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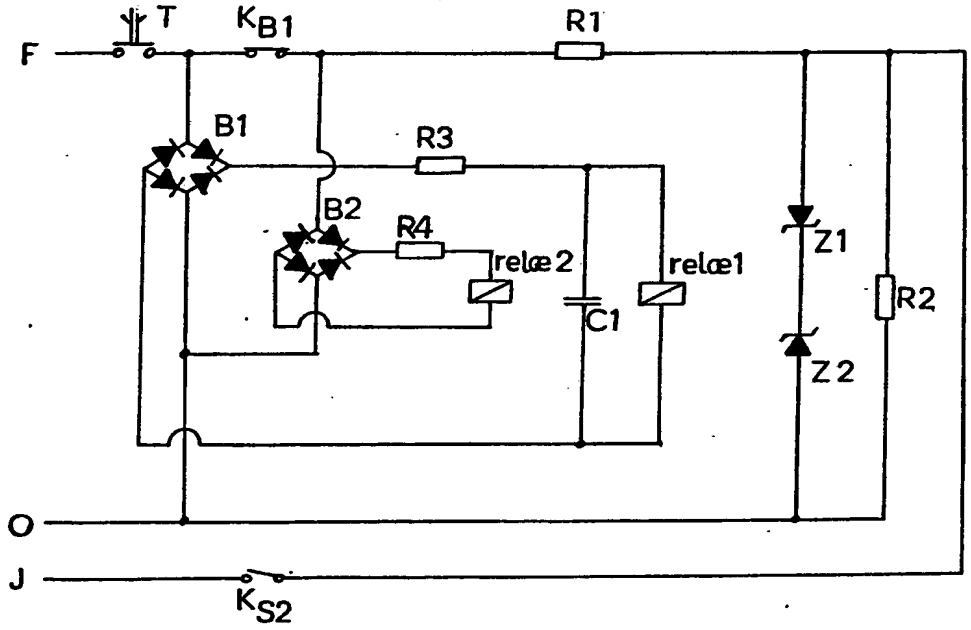

AN9

(57) Abstract

Method for testing fault current protection circuits in permanently earthed systems by producing by means of two mutually opposed Zener diodes a constant AC voltage whose magnitude is equal to the given maximum contact voltage which it is permissible to apply to the fault current protection circuits. This AC voltage, corresponding to the RMS value of a sinusoidal voltage, is applied to the resistance of the protective circuit, causing a fault current which, depending on the value of the earth contact resistance, will trip the fault current breaker if the current exceeds the fault current breaker tripping current. In order to limit the energy developed in the circuit a timer element is included which automatically breaks the test voltage as soon as the test has been completed. A safety device against wrong connection is also included.

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Test Circuit for Fault Current Protection Circuits

The present invention is concerned with a test circuit for fault current protection circuits of the type having a contact that is tripped by a fault current exceeding a predetermined value and thereby disconnects the mains from the protected installation or consumer, which test circuit has means for producing from the mains voltage a test voltage which is lower than the mains voltage and may be, for example, a voltage with which human contact is deemed permissible (permissible contact voltage), such as 50 to 65 volts, and which is applied to a protective circuit (chassis or earth wire).

Fault current protection circuits are known, for example, under the names of FI or HFI relays. Such relays contain a summation element, e.g. a summation current transformer, which measures the sum of the currents in the supply wires to the protected consumer, e.g. an appliance or a section of an installation. If the consumer is free from insulation faults the sum of the currents in the supply wires will be zero, and no voltage, for example, will be induced in the secondary winding of the transformer, which serves as the measuring and tripping winding. If, however, there is current flow to the chassis in the appliance or the section of installation, or if a person touches a live part and thus creates an artificial path to earth, a larger or smaller fraction of the current – the fault current – will flow to earth via this path, and the current sum will no longer be zero. As a result of this imbalance between the currents in the supply wires a voltage is induced in the secondary winding of the transformer which, if the fault current is heavy enough, causes a relay to disconnect the mains from the appliance or the section of installation. The relay is dimensioned to disconnect the mains not later than the moment when the fault current reaches a value at which it begins to be dangerous (approx. 30 mA in an HFI relay) or, in the case of an earthed appliance, produces across the earthing resistance a voltage exceeding a permissible contact voltage, e.g. a voltage of 50 to 65 V, if the earth wire (protective wire) is intact. The earthing resistance refers here to the aggregate resistance between an earthed consumer and earth, i.e. including the resistance of the earth wire itself and the contact resistance between an earth plate and earth, and the relay is to disconnect the mains from the consumer, at the latest, when the current flowing through the tripping coil is

equal to that which the permissible contact voltage can produce when applied to the earthing resistance.

The protection can be made ineffective or at least inadequate not only by defects in the relay itself but also by an excessive earthing resistance, as a voltage equal to the permissible contact voltage will then be unable to produce a current large enough to trigger the relay. For this reason circuits for fault current protection must be regularly tested.

A previously known method of doing this is to apply to the protective circuit of the protected consumer a voltage which is gradually increased, e.g. by means of a test rheostat or a variable-ratio transformer, until the fault current produced by the voltage causes the relay to operate, whereupon the voltage and current are measured by means of instruments. This procedure is cumbersome and it requires the voltage and current to be measured at the exact moment when the relay operates. It must further be ensured that the test voltage applied does not exceed the permissible contact voltage.

Another known method (cf. German disclosure no. 1 136 003) is to connect a choking coil with one outlet between a phase and the neutral conductor. A measuring or test voltage equal to the permissible contact voltage is tapped via the outlet and applied to the earth wire so as to produce a fault current. When the test voltage is equal to the permitted contact voltage the protective relay should operate. If this does not occur, the relay is faulty or the earthing resistance is too great and replacement or repair is necessary.

Here there is no need for measuring instruments, but it is a drawback that the test voltage is not independent of the mains voltage. If the mains voltage fluctuates, the test voltage will also fluctuate, possibly to a value somewhat higher than the permissible contact voltage, or else the tap on the coil must be moved. Furthermore, the test voltage applied to the protective wire (earth wire) by means of the known circuit is not independent of load, i.e. independent of the resistance to earth, and the range of fault current that can be covered with any given choking coil is quite limited.

The aim of the present invention is to provide a reliably functioning circuit which, moreover, does not require the use of measuring instruments, but which makes it possible to test by simple means, reliably, and independent of fluctuations in the mains voltage and the load, the circuit for fault current protection.

For this purpose a circuit of the type mentioned in the ingress is characterized, according to the invention, in that the means for producing the test voltage comprise a voltage stabilizer circuit which is connected to the mains voltage and that the protective circuit is connected to the stabilized voltage output of said voltage stabilizer.

As a consequence of the use of a voltage stabilizer, e.g. incorporating Zener diodes, to produce the test voltage, it is ensured that said test voltage will always have the same value irrespective of possible mains voltage fluctuations, and as a consequence of the earth wire being connected to the thus stabilized test voltage source – and not to an outlet on a resistor or choking coil connected between one phase and neutral – it is further ensured that load fluctuations due to differing earthing resistances will have no effect on the value of the test voltage.

Hence the circuit according to the invention will, if connected as stated, with the aid of the fault current relay cause disconnection of the mains voltage automatically, without the necessity to allow for possible mains voltage fluctuations, and without risk of elevated contact voltages, provided that the said relay and the earth wire are not defective. If the relay fails to disconnect it is a sign that either the relay or the earth wire is defective or possibly that the contact resistance of an earth plate to earth is too great. The circuit functions without the use of measuring instruments.

The voltage stabilizer circuit can, as indicated, be appropriately constructed of Zener diodes, preferably according to the invention of two Zener diodes each having a Zener voltage equal to the desired test voltage, e.g. the permissible contact voltage, which are connected to the mains voltage, wired up in series oriented in mutually opposite directions and in series with a limiter resistor, the earth wire being connected to the terminal between one Zener diode and the limiter resistor.

Zener diodes can be subjected to quite heavy currents, and the circuit according to the invention, using Zener diodes as voltage-stabilizing devices, can therefore cover a very wide range of fault currents, so that the same test circuit can be used without modification to test several different fault current breakers, e.g. several different HFI relays or FI relays, which may have tripping currents ranging from 0.3 A to 1 A, whereas with the abovementioned circuit disclosed in

German Patent No. 1 136 003 one would expect to have to use a number of different choking coils.

As Zener diodes, in particular, are lighter, less bulky, and cheaper than choking coils, the circuit according to the invention makes available a test apparatus that weighs less, takes up less space, and costs less than known apparatuses for testing fault current breakers such as HFI and FI relays.

The invention will now be more particularly described with reference, by way of example, to the drawing, which shows in a simple and schematic fashion a circuit for testing fault current breakers.

The letter F in the drawing denotes a phase connection, O a neutral connection, and J an earth connection. Mains voltage is applied to the test circuit by the activation of a manually operated contact shown as a pushbutton contact T. Mains current is thereby caused to pass through a series resistor R1 and through a parallel arrangement of a resistor R2 with two series-connected Zener diodes Z1, Z2 oriented in mutually opposed directions. The Zener diodes Z1 and Z2 each have a Zener voltage equal to the test voltage which it is desired to apply to the protective or earthwire circuit, which is connected to the terminal between the Zener diodes and resistor R1, which functions as a limiter resistor, and it is thus effectively ensured that the voltage over the earth wire can never exceed this desired test voltage or measuring voltage, which may for example be equal to the permissible contact voltage. When this voltage is accordingly applied to the earth wire, a fault current will flow in this wire which will cause the fault current breaker to trip and disconnect the mains from the installation or appliance in question. If this does not occur the fault current breaker is defective or the earth wire is defective, possibly broken, or the contact resistance between an earth plate and earth is too great, so that the applied test voltage, and hence also a voltage of the same magnitude passing to earth under normal operating conditions, is unable to produce the fault current necessary to trip the fault current breaker. In order further to ensure that at least the test circuit operates correctly even under these circumstances, resistor R2 serves a load resistor to ensure that the Zener diodes are active even if the fault current is weak.

For timing purposes a relay-operated breaking contact KB1 may be provided in series with the manually operated contact T, as shown in the figure. This contact KB1, which is closed in the initial state, is opened by a relay 1 when a sufficiently large activating current is

supplied to the latter over a rectifier bridge network B1, connected to mains voltage, and over an RC network R3, C1. The time at which this occurs, and hence the length of the test period, is determined by the time constant R3.C1. Inasmuch as the test period is thus limited, a limit is likewise placed on the period during which the protected plant can remain live if the protective circuit is defective, and furthermore a limit is placed on the energy developed in the circuit during a test and hence on the power for which the circuit according to the invention must be designed.

Upon operation of contact T mains voltage is also supplied to a rectifier network, shown in the figure as a bridge network B2, which activates via a resistor R4 a relay 2 that closes the making contact KS2, which in the example illustrated supplies the earth wire with the aforementioned test or measurement voltage. As will be apparent, this contact KS2 is not strictly essential to the operation of the circuit, but in case of faulty connection it prevents damage from being done to the circuit or dangerous contact voltages from occurring before the contact T is operated to start the test period proper, which, whether under manual or relay control, is of course to be very short.

Claims

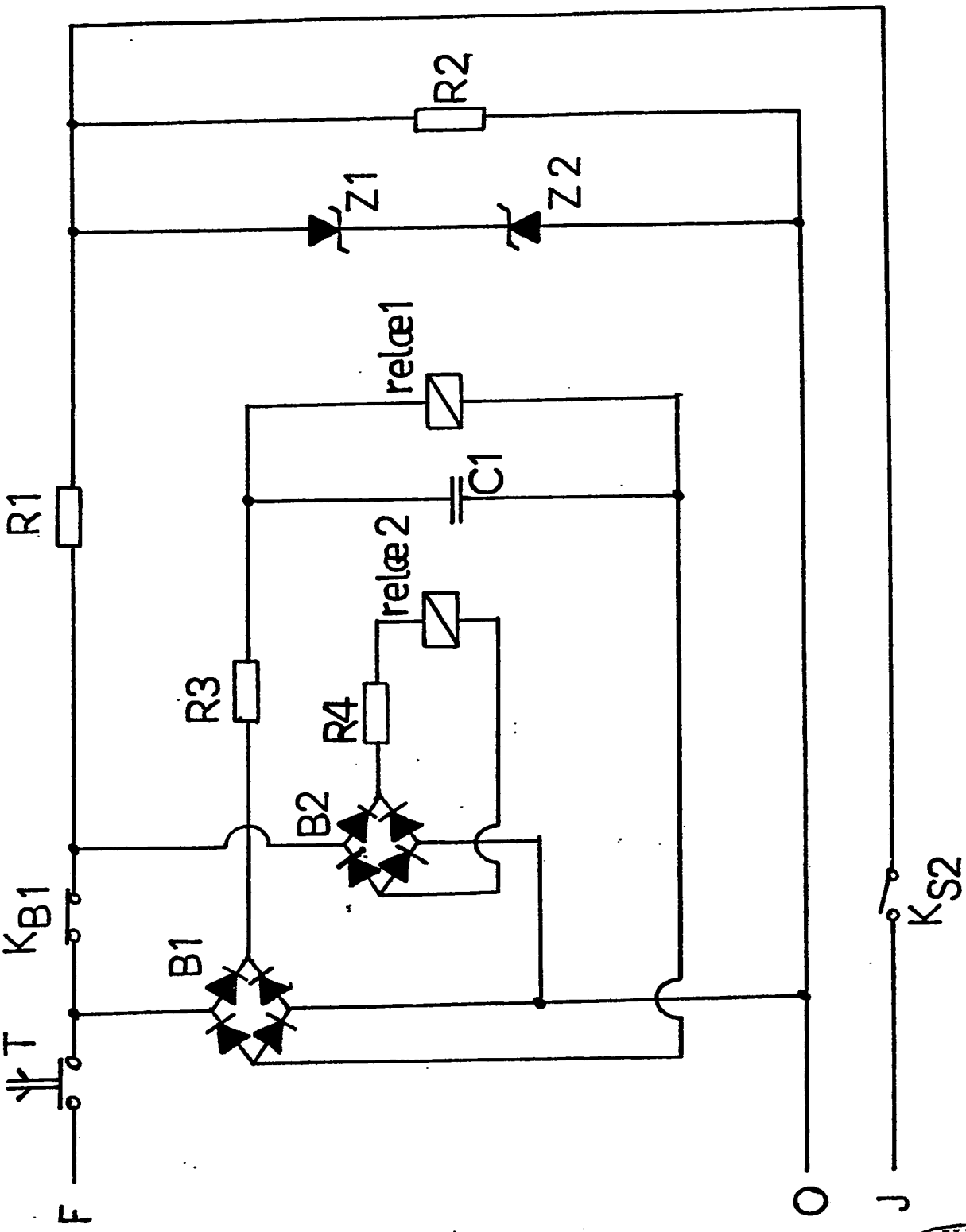
1. A test circuit for fault current protection circuits of the type having a contact that is tripped by a fault current exceeding a certain predetermined value and thereby disconnects the mains from the protected installation or consumer, which test circuit has means for producing from the mains voltage a test voltage which is lower than the means voltage and may be, for example, equal to that voltage with which human contact is deemed permissible (permissible contact voltage), e.g. 50 to 65 volts, and which is applied to a protective circuit (chassis or earth wire); characterized in that the means for producing the test voltage comprise a voltage stabilizer circuit that is connected to the mains voltage (F) and that the protective circuit (J) is connected to the stabilized voltage output of the voltage stabilizer.

2. A test circuit as claimed in Claim 1, characterized in that the voltage stabilizer circuit includes a Zener diode circuit, preferably with two Zener diodes (Z1, Z2) each having a Zener voltage equal to the desired test voltage, e.g. the permissible contact voltage, which are connected to the mains voltage, wired up in series oriented in mutually opposed directions and in series with a limiter resistor (R1), the protective circuit (J) being connected to the terminal between one of the Zener diodes (Z1) and the limiter resistor (R1).

3. A test circuit as claimed in Claim 1 or 2, characterized by a timer element (1, KB1), e.g. a relay (1) activated via an RC network (R3, C1), which after a predetermined lapse of time from the connection of the test circuit to the mains breaks the connection between the mains and the test circuit.

4. A test circuit as claimed in any of Claims 1 to 3, characterized in that the protective circuit (J) is connected via a relay contact (KS2), which is activated by the voltage applied to the test circuit.

FIG. 1



INTERNATIONAL SEARCH REPORT

International Application No PCT/DK83/00080

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

G 01 R 31/00, H 02 H 1/00, H 01 H 83/04

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	G 01 R 31/00,02, H 01 H 71/04,83/04, H 02 H 1/00, 3/16,17,11/00
US Cl	324: 28, 51, 415, 418

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	DE, B2, 1 943 714 (HELWIG) 4 March 1971	
Y	DE, B, 1 092 125 (LAUERER) 3 November 1960	
Y	EP, A1, 0 006 602 (GOSSEN GMBH) 9 January 1980 & DE 2 829 407 AT 1032	
A	DE, B1, 2 653 704 (MÜLLER & WEIGERT GMBH) 8 December 1977	

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [9]
1983-10-08	1983 -11- 15
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Swedish Patent Office	Bertil Nordenberg

Form PCT/ISA/210 (second sheet) (October 1981)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields Searched (cont)

National Cl 21e: 29/11, 37/03

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This International search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ...., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.